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(56) Asnovich E. Z. et al. Electrically Insulating Materials with High Heat Resistance. M. Energy, 1979, p. 201.

(54) SUBSTRATE FOR PRINTED CIRCUIT BOARD AND METHOD FOR MANUFACTURE THEREOF

(57) Field of Utilization: printed board fabrication technology. Essence of the Invention : a substrate for a printed circuit board is formed as a packet of basalt fabric sheets impregnated with a polymer binder comprising a boron nitride powder in an amount of 2-10% based on the weight of the binder. The powder has a particle size of 0.5-20 μm. Boron nitride is introduced into the polymer binder prior to impregnation of the basalt fabric. The invention increases heat resistance and improves thermophysical and dielectric properties of the substrate. 2 claims. 3 tables.

The present invention relates to electrically insulating materials, more specifically, to a substrate for printed circuit boards, and to a method for the manufacture of the substrate. The invention can be successfully utilized in the field of computers, electronics and the like.

Printed circuit boards are usually in the form of layered electrically insulating substrate clad on one or two sides with a metallic foil.

One of the conventional substrates for printed circuit boards had a multilayer structure consisting of basalt fabric sheets impregnated with a polymer binder based on phenol-formaldehyde and polyimide resins [1].

However, such substrates, in particular, substrates based on phenol-formaldehyde resins, have a low level of heat resistance, thermophysical and electric properties, which places limitation on the range of their application.

A method for the fabrication of a substrate for printed circuit boards is also known this method comprising the steps of impregnating a basalt fabric with an epoxy polymer binder, drying the fabric, cutting to obtain preforms, assembling the preforms to obtain a packet, and thermally pressing the packet [2]. The drawback of this method is in that the obtained substrates have a low thermal conductivity and insufficient heat resistance and the values of their dielectric loss tangent are still high.

The object of the present invention is to improve heat resistance, thermophysical properties and dielectric properties of substrates for printed circuit boards.

This object is attained by employing a substrate for a printed circuit board having a multilayer structure consisting of basalt fabric sheets impregnated with a polymer binder, wherein the polymer binder additionally contains boron nitride in an amount of 2 to 10% based on the binder weight.

In the method for the fabrication of a substrate for printed circuit boards, comprising the steps of impregnating a basalt fabric with a polymer binder, drying, cutting to preforms, assembling the preforms into a packet and thermal pressing of the packet, the above object is attained by introducing boron nitride with a particles size of 0.5 to 20 μm in an amount of 2 to 10% based on the binder weight into the binder prior to impregnation of the basalt fabric with the binder.

Boron nitride is widely used for the manufacture of heat-resistant ceramics [3, 4]. However, the use of boron nitride in the fabrication of substrates for printed circuit boards is not known in prior art and is not dictated by simple utilization of known properties of the substance, because when its concentration in the binder is outside the claimed range (2-10%), the above-described object is not attained.

The utilization of the selected order for the introduction of boron nitride in the form of dispersed particles with a size of 0.5 to 20 μm, that is, the direct introduction into the polymer binder under stirring prior to impregnation of the basalt fabric, provides for a uniform distribution of boron nitride in the polymer matrix and effective interaction of its highly developed surface with the binder and basalt fabric during thermal pressing, which results in qualitative changes in the substrate properties.

The suggested substrate for printed circuit boards has a multilayer structure consisting of basalt fabric sheets impregnated with a polymer thermosetting binder containing 2-10% boron nitride based on the binder weight.

The implementation of the method for the preparation of the substrate will be illustrated below by the following examples.

Example 1. An epoxy binder is charged into a reactor provided with a mechanical stirrer. Then, boron nitride with a particle size of 0.5-20 μm is added in an amount of 5%, and the components are stirred for no less than 5 min to obtain a homogeneous distribution of the finely dispersed product in the whole binder. The obtained mixture is used to impregnate a basalt fabric which is then dried at a temperature of 80°C for no less than 60 min. The dried fabric is cut to obtain preforms which are assembled into a packet for the fabrication of an electrically insulating material with a thickness of 1.5 mm. The packet is subjected to thermal pressing at a temperature of 160°C under a pressure of 350 MPa for 60 min. The press-form is then disassembled, edges are cut out, and the obtained electrically insulating material is inspected.

Results obtained with the conventional and suggested methods for the fabrication of an electrically insulating material are presented in Table 1 for different concentrations of boron nitride.

Data presented in the table show that the preliminary introduction of boron nitride with a particle size of 0.5-20 μm in an amount of 2-10% based on the binder weight into the epoxy polymer binder makes it possible to improve heat resistance of the obtained material, as demonstrated by the fact that its bending strength at a temperature of 180°C was increased by 20-33%, while its thermal conductivity was increased by 38-55% and its dielectric loss tangent was decreased by 13-65%.

Example 2. A polyimide binder [5] is charged into a reactor provided with a mechanical stirrer. Then, boron nitride with a particle size of 0.5-20 μm is added in an amount of 5%, and the components are stirred to obtain a homogeneous distribution of the finely dispersed product in the whole binder. The obtained mixture is used to impregnate a basalt fabric which is then dried at a temperature of 180°C for 1 h. The dried fabric is cut to obtain preforms which are assembled into a packet. The packet is subjected to thermal pressing at a temperature of 310°C under a pressure of 450 MPa for 1 h. The press-form is then disassembled, edges are cut out, and the obtained electrically insulating material is inspected.

Results obtained with the conventional and suggested methods for the fabrication of an electrically insulating material are presented in Table 2 for different concentrations of boron nitride.

Data presented in the table show that the preliminary introduction of boron nitride with a particle size of 0.5-20 μm in an amount of 2-10% based on the binder weight into the polyimide binder makes it possible to increase its bending strength at a temperature of 300°C by 18-21%, increase its thermal conductivity by 10-24% and decrease its dielectric loss tangent by 25-75%.

Example 3. A phenol-formaldehyde binder is charged into a reactor provided with a mechanical stirrer. Then, boron nitride with a particle size of 0.5-20 μm is added in an amount of 5%, and the components are stirred to obtain a homogeneous distribution of the finely dispersed product in the whole binder. The obtained mixture is used to impregnate a basalt fabric which is then dried at a temperature of 80°C for 30 min. The obtained elements are assembled into a packet. The packet is subjected to thermal pressing at a temperature of 160°C under a pressure of 350 MPa for 60 min. Upon cooling, the press-form is disassembled, edges are cut out, and the obtained electrically insulating material is inspected.

Results obtained with the conventional and suggested methods for the fabrication of an electrically insulating material are presented in Table 3 for different concentrations of boron nitride.

Data presented in the table show that the preliminary introduction of boron nitride with a particle size of 0.5-20 μm in an amount of 2-10% based on the binder weight into the polyimide binder makes it possible to increase its bending strength at a temperature of 250°C by 28-43%, increase its thermal conductivity by 8-30% and decrease its dielectric loss tangent by 33-53%.

The utilization of the suggested method for the manufacture of an electrically insulating material for printed circuit boards with improved balance of heat resistance, thermophysical properties and dielectric properties makes it possible to improve the operation reliability of components of electronic devices with high thermal load, which results in the decreased total number of malfunction events and increased reliability of electronic equipment.

Patent Claims

1. A substrate for a printed circuit board formed as a multilayer structure consisting of basalt fabric sheets impregnated with a polymer binder, characterized by the fact that a boron nitride powder is introduced into the polymer binder in an amount of 2-10% based on the weight of the binder.

2. A method for the fabrication of a substrate for a printed circuit board comprising the steps of impregnating a basalt fabric with a polymer binder, drying, cutting to obtain sheets, assembling a sheet package, and thermal pressing, characterized by the fact, that a boron nitride

powder with a particle size of 0.5-20 μm is introduced into the polymer binder in an amount of 2-10% based on the weight of the binder prior to impregnation of the basalt fabric.

Table 1

Effect of the manufacturing method on characteristics of an electrically insulating material based on an epoxy binder

Manufacturing method	Concentration of boron nitride, %, in the binder	Bending strength, MPa, at a temperature of 180°C	Thermal conductivity coefficient, W/m-°C	Dielectric loss tangent at a frequency 10^3 Hz
Conventional	None	300	0.29	0.023
According to invention	1	320	0.32	0.015
	2	380	0.40	0.010
	5	400	0.44	0.008
	10	360	0.45	0.020
	12	310	0.45	0.023

Table 2

Effect of the manufacturing method on characteristics of an electrically insulating material based on an polyimide binder

Manufacturing method	Concentration of boron nitride, %, in the binder	Bending strength, MPa, at a temperature of 300°C	Thermal conductivity coefficient, W/m-°C	Dielectric loss tangent at a frequency 10^3 Hz
Conventional	None	380	0.50	0.004
According to invention	1	430	0.50	0.004
	250 (sic)	450	0.55	0.003
	5	460	0.62	0.001
	10	450	0.55	0.003
	11	440	0.50	0.006

Table 3

Effect of the manufacturing method on characteristics of an electrically insulating material based on an phenol-formaldehyde binder

Manufacturing method	Concentration of boron nitride, %, in the binder	Bending strength, MPa, at a temperature of 250°C	Thermal conductivity coefficient, W/m-°C	Dielectric loss tangent at a frequency 10^3 Hz
Conventional	None	280	0.37	0.030
According to invention	1	300	0.38	0.020

	2	360	0.40	0.020
	5	400	0.45	0.014
	10	380	0.48	0.020
	11	350	0.44	0.040